United States Department of Agriculture

Forest Service

North Central Forest Experiment Station

General Technical Report **NC-73**

FIREFAMILY: Fire Planning with Historic Weather Data

William A. Main, Robert J. Straub, and Donna M. Paananen

CONTENTS

	Page
FIRDAT ROUTINE	
Header Page	2
Daily List	2
Summary of Station Statistics	5
Frequency Distributions Table	5
Frequency Distributions Graph	5
Manning Level Table	9
Observed Weather Elements	9
FIRDAT Lead Card One	9
FIRDAT Lead Card Two	10
SEASON ROUTINE	11
Seasonal Table	11
Graphing Options	11
Fire Manager's Graph	13
Persistence Probability Table	13
BI Seasonal Severity	14
BI Seasonal Severity List	14
BI Seasonal Severity Summary Table	15
SEASON Lead Card Three	17
FIRINF ROUTINE	17
Adjective Class Matrix	18
Adjective Class Calendar	18
Probability Analysis	18
FIRINF Lead Card Four	20
CONCLUSION	21
ACKNOWLEDGMENTS	22
LITERATURE CITED	22
APPENDIX I: LEAD CARD FORMATS	22
Ia FIRDAT Control—Lead Card One	23
Ib FIRDAT Control—Lead Card Two	24
Ic SEASON Control—Lead Card Three	25
Id FIRINF Control—Lead Card Four	26
APPENDIX II: OUTPUT PAGE ESTIMATOR	27
APPENDIX III: JOB RUNSTREAMS AND PASSING FILE FORMAT	27
IIIa Running FIREFAMILY Using Historical Weather Data	28
IIIb Running FIREFAMILY Using a Previously Created Passing File	29
APPENDIX IV: ABBREVIATIONS AND GLOSSARY	30

North Central Forest Experiment Station
Forest Service—U.S. Department of Agriculture
1992 Folwell Avenue
St. Paul, Minnesota 55108
Manuscript approved for publication April 31, 1982.
1982

FIREFAMILY: FIRE PLANNING WITH HISTORIC WEATHER DATA

William A. Main, *Computer Programmer,*
North Central Forest Experiment Station,
East Lansing, Michigan,
Robert J. Straub, *Computer Specialist,*
Land Management Planning Systems,
Fort Collins, Colorado,
and **Donna M. Paananen,** *Technical Writer,*
North Central Forest Experiment Station,
East Lansing, Michigan

One of the missions of wildland fire management is to integrate fire with other land management activities to achieve desired objectives at the lowest cost. When fire managers know how fires are likely to behave in an area as well as that area's associated weather, topography, and fuel moistures, they can establish limits for public and industrial activities, plan prescriptions for burning, pre-position and dispatch suppression resources, and select appropriate wildfire suppression tactics. This publication will show fire managers how to employ FIREFAMILY, a computer program that uses historic weather data to predict future fire management needs. The publication also identifies the various options available within FIREFAMILY'S major routines.

The three major routines of FIREFAMILY are FIRDAT, SEASON, and FIRINF. In the routine FIRDAT, fire weather station characteristics are combined with daily weather records and the equations of the National Fire-Danger Rating System (NFDRS) to produce **frequency distributions tables** and **graphs** of the NFDRS indexes and components. These **frequency tables** and **graphs** are useful for determining manning levels. For an explanation of the NFDRS, see Deeming *et al.* (1977), Burgan *et al.* (1979), and Helfman *et al.* (1980). SEASON and FIRINF re-read data created by FIRDAT and organize it into probabilities, seasonal graphs, calendars, and other fire management tools.

In the following sections, we discuss each of these three major routines, emphasizing what you will be required to provide as well as how you can analyze the various products. We also provide an Appendix to acquaint you with the Fort Collins Computer Center (FCCC) job-control language required to operate this program. Because FIREFAMILY continually grows to meet users' needs, you might notice slight differences between the output used for illustration and that received from the Fort Collins computer. For updated instructions, contact the Cooperative Fire Protection Staff of the USDA Forest Service at Boise, Idaho (Boise Interagency Fire Center, 3905 Vista Avenue, Boise, Idaho, 83705).

FIRDAT ROUTINE

You will begin the analysis of your data by providing information to FIRDAT on lead cards. This information includes the station's elevation, latitude, fuel model, slope class, herbaceous type, and climate class (see Appendix I). FIRDAT will read this information as well as your historical weather data on file at the National Fire Weather Data Library (NFWDL) (see Furman and Brink 1975).

FIRDAT examines your weather data on a daily basis to determine the best option to use in computing the daily fuel moistures. Then, using the NFDRS equations, FIRDAT calculates the NFDRS components and indexes. These daily values of weather, indexes, and components can be saved for later use; they **must** be saved if you are going to use SEASON and/or FIRINF. You can request a printout of these values called the **daily list.**

An innovative aspect of this routine allows you to define the specific dates for a fire season for a particular protection area. This feature is particularly helpful if you have a split fire season. For example,

in the Northeast fires occur frequently in both the spring and the fall, but few fires occur in the summer. You might select April 10, for example, as the beginning of the fire season and November 9 as its end on lead card one (Appendix Ia). Then on lead card two (Appendix Ib), you would exclude the summer period from June 21-September 11 when there are few fires. FIRDAT would then provide a frequency analysis for only the high risk spring and fall periods.

FIRDAT always prints a **summary of station statistics** for each year you select. When the data for your station end, the routine prints **frequency distributions tables** and **graphs** for those NFDRS indexes and components you chose on lead card one.

Header Page

FIREFAMILY always prints a **header page** (fig. 1) showing the information you supplied on your lead cards. Always keep your **header page** attached to the output as a permanent record of the input you used for that run. The **header page** repeats character-by-character the information you supplied. The program then inspects your lead cards for consistency and format. For instance, if the weather information read by the computer is not for your station, or is outside the years that you specified on your lead card, you will receive an error message.

The large block number 240107 on our **header page** (fig. 1) is the weather station number. Bold letters **A** and **B** point out the information supplied on the FIRDAT lead cards. Letter **C** identifies a SEASON lead card and letter **D** identifies two FIRINF lead cards. Note that you can provide up to three separate lead cards for both SEASON and FIRINF. In our example (**D**) we provided two lead cards, which resulted in two separate FIRINF runs.

The routine prints a KEY line under the lead CARD line to identify the entries immediately above it. Find ! = PASSING FILE (above **E**) on lead card one. The KEY character "!" is associated with the **passing file**, an essential FIREFAMILY component that passes FIRDAT data to SEASON and FIRINF. Now find the "!" in the KEY line. Look directly above the "!" and find a "T." The "T" stands for true, indicating that a **passing file** was created in this run. An "F" (false) there would have meant that the passing file would not be created and would not be available for use with SEASON and FIRINF.

Daily List

If you choose to print the weather data, the routine will print the **daily list** (fig. 2). Always examine your **daily list** closely to ensure that the historical weather elements on the left hand side correspond to your original weather records.

At the top of each page the title "DAILY LIST" appears. Included on the left are the FIREFAMILY version number "1978 NFDRS VERSION FFY 2.5," the administrative ownership "KOOTENAI NF," the station name and number "LIBBY MONTANA 240107," and the user-selected MODEL—"C," SLOPE CLASS—"2," HERB TYPE—"A," and CLIMATE CLASS—"2." Included on the right are the date of the run, page number, station elevation and latitude, and the fire season dates.

Bold **A** indicates abbreviated column headings. From left to right, these abbreviations stand for: date of observations; processing option; state of the weather; dry bulb temperature; relative humidity; wind speed; maximums and minimums of temperature and relative humidity; amount and duration of precipitation; lightning activity level; human-caused risk; the six fuel moistures: woody, herbaceous, 1-hour, 10-hour, 100-hour, and 1,000-hour; NFDRS components: ignition, spread, and energy release; NFDRS indexes: human-caused fire occurrence, lightning-caused fire occurrence, burning, and fire load.

Three special symbols may appear in the printout. An asterisk "*" after either the precipitation duration or the 10-hour moisture indicates that the values were computed rather than read from the data (**B**). A plus sign "+" after the 1-hour moisture shows that it was raining at observation time (0). A "T" after a zero "0" in precipitation amount indicates a trace. A key to this information appears at the bottom of each **daily list** page.

At the end of each month, FIRDAT produces a summary report (**D**) of the number of days in the

```
  2222          44      000000       11       000000    77777777
22222222    44  44      000000      111       000000    77777777
22    22    44  44    00    00     1111     00    00        77
      22    44  44    00    00    11111     00    00        77
    22      44  44    00    00       11     00    00       77
   22       44  44    00    00       11     00    00       77
  22        44  44    00    00       11     00    00      77
 22         44444444  00    00       11     00    00      77
22          44444444  00    00       11     00    00     77
22                44  00    00       11     00    00     77
22222222          44    000000 11111111     000000     77
22222222          44    000000 11111111     000000     77
```

A.

```
.LEAD CARD ONE PROVIDES THE STATION DESCRIPTION AND CONTROLS FOR FIRDAT.
.
CARD.1KOOTENAI NF LIBBY MONTANA        240107 207049C2A27277 5 9 9 9TTTTTTTTTFFT
KEY . , UNIT NAME,,   STATION NAME  .,,NMBR,,ELV,LLMSHC,YR,,BGNEND,1234567FD+W!
    .ELV= ELEVATION ,LL-M-S-H-C= LATITUDE,MODEL,SLOPE,HERB TYPE,CLIMATE, YR= YEARS, BGNEND= FIRE SEASON DATES,
    .1-7=SELECTED FREQUENCY DIST., F=MOIST FREQS, D=DAILY LIST, +=NO FIRDAT, W=LIST WEATHER ONLY, !=PASSING FILE.
    .
```

B.

```
.LEAD CARD TWO PROVIDES ADDITIONAL CONTROLS.
.
CARD.2 1.00 12 12 6 1 910 0 0 0 0 0 0 0 0   0   069097
KEY . (LRS)  W  E(GU)(FR)MSHCMSHCMSHCMSHC(LOW-HI)F1%2%
    . (LRS)= LIGHTNING SCALING FCT, HUMAN RISK W= WEEKDAY, E= WEEKEND (GU)= GREENUP MONTH-DAY,(FR)= FREEZE,
    .MSHC= MODEL-SLOPE-HERB-CLIMATE, (LOW-HI)= SKIP PERIOD, F= FILL SEA & INF ARRAYS, 1%2%= MANNING PERCENTILES.
    .
```

C.

```
.LEAD CARD THREE MAY BE REPEATED UP TO 3 TIMES, AND PROVIDES THE CONTROL FOR SEASON.
.
CARD.311234567TT 5F6  0  0  0  0  0  0T  0   .0  .00
KEY . L1234567GT()YP,6 PERST DIVISNS ,B90% EXBI,EXDY
    .L= VARIABLE LIST, 1-7= SELECTED VARIABLES, G= GRAPHS, T= TABLES, ()= AVERAGING PERIOD,
    .Y= SINGLE YEARS ,P= PERSIST INDEX, B= BI SEVERITY,
    .90%= BI PERCENTILE VALUE, EXBI= AV.BI SUM, EXDY= AV.DAYS GREATER THAN 90%
    .
```

D.

```
.LEAD CARD FOUR MAY BE REPEATED UP TO 3 TIMES, AND PROVIDES THE CONTROL FOR FIRINF.
.
CARD.4TF0  0  0  0  0  0  0  0  0  0  00  0  0  0  0  0  0  0  0  0  0
CARD.4FF3  5 10 15 20 25 50  0  0  0  06  7 14 21 28 34100  0  0  0  0
KEY . APX,    TEN HORIZ DIVISIONS     ,Y,    TEN VERTC DIVISIONS     ,
    .A= ADJECTIVE CLASS, P= PRECAUTIONS CLASS, X= HORIZONTAL INDEX, Y= VERTICAL INDEX.
```

E

Figure 1.—*Header page.*

1978 NFDRS VERSION FFY 2.5 DAILY LIST 22 JAN. 81 PAGE 2
KOOTENAI NF LIBBY MONTANA 240107 ELEVATION- 2070 LATITUDE-49
MODEL-C SLOPE CLASS-2 HERB TYPE-A CLIMATE CLASS-2 FIRE SEASON- 5/ 9 TO 9/ 9

A

DY	O P	S W	D TMP	B HUM	FFL	WD SP	TEMP MAX	TEMP MIN	RH MAX	RH MIN	PRECIP AMNT	PRECIP DUR	LAL	HUM RSK	WDY FM	HRB FM	1 HR	10 HR	100 HR	1000 HR	IGN COM	SPD COM	ENR COM	HOI NDX	LOI NDX	BUR NDX	FLI NDX
MAY					1972																						
1	1	1	62	23	3	64	19	99	20	.00	0	1	12	60	5	5	10	15	20	23	7	14	3	0	24	17
2	1	1	67	43	0	70	25	99	20	.00	0	1	12	60	8	8	13	14	19	11	4	10	1	0	16	11
3	1	1	60	55	0	70	28	66	22	.00	0	1	12	60	9	9	14	12	19	8	4	8	1	0	15	11
4	1	2	62	51	3	70	31	99	30	.00	0	1	12	60	10	10	14	13	19	9	6	8	1	0	18	13
5	1	2	62	43	0	70	41	99	40	.00	0	1	12	60	9	9	13	14	18	9	4	9	1	0	16	11
6	1	2	59	36	0	64	39	99	36	.00	0	1	12	60	8	8	13	14	18	11	4	10	1	0	16	11
7	1	2	60	50	0	66	37	99	30	.00	0	1	12	60	10	10	14	14	18	7	4	8	1	0	15	11
8	1	6	50	81	0	67	43	100	42	.04	1*	1	12	60	18	20+	22	15	18	0	0	0	0	0	0	0
9	1	2	52	76	0	56	40	99	52	.35	2*	1	12	60	14	14	20	16	18	2	3	3	0	0	8	6
10	1	3	59	54	2	64	40	99	52	.00	0	1	12	60	11	11	15	16	18	6	5	7	1	0	15	11
29	1	0	86	27	2	87	39	99	22	.00	0	1	12	60	5	5	9	13	16	26	6	15	3	0	24	17
30	1	0	91	26	0	93	42	99	26	.00	0	1	12	60	5	5	8	13	16	25	5	16	3	0	22	16
31	1	9	75	63	3	85	49	99	32	.10	1*	1	12	60	12	12	14	13	16	6	5	7	1	0	16	11
D 31										.82	9		372							420	174	303	48	0	571	407
JUNE					1972																						
1	1	1	79	27	4	82	44	99	27	.29	2*	1	12	65	13	E 5	9	14	16	27	8	14	3	0	27	19
2	1	1	82	19	3	82	36	99	19	.00	0	1	12	69	20	4	8	13	15	30	7	16	4	0	26	19
3	1	1	76	36	1	80	46	99	22	.00	0	1	12	73	30	7	11	13	15	15	4	12	2	0	18	13
4	1	1	78	26	2	80	36	99	26	.00	0	1	12	77	36	5	9	13	15	22	5	14	3	0	21	15
5	1	0	85	27	4	87	37	99	18	.00	0	1	12	81	43	5	9	13	15	28	7	13	3	0	24	17
6	1	0	91	18	3	93	37	99	12	.00	0	1	12	85	49	4	7	12	15	33	6	15	4	0	24	17
7	1	3	76	46	5	81	54	99	38	.00	0	1	12	88	58	9	12	13	15	11	6	8	1	0	18	13
8	1	3	75	63	3	75	56	99	48	.16	1*	1	12	92	66	12	14	14	15	5	4	5	1	0	12	9
9	1	2	71	73	2	78	57	99	48	.20	1*	1	12	97	74	13	16	14	15	3	3	3	0	0	8	6
10	1	9	80	33	3	82	56	99	22	.45	2*	1	12	102	81	7	9	14	15	13	3	9	2	0	14	10
11	1	3	47	93	0	60	44	99	42	.55	3*	1	12	109	95	24	30	16	16	0	0	0	0	0	0	0
12	1	3	53	65	2	56	39	99	50	.19	1*	1	12	114	100	13	18	16	16	1	1	1	0	0	3	2

(* = DURATION OR 10HR MOISTURE WAS CALCULATED. T = TRACE OF PRECIP. + = RAINING AT OBS TIME.)

B

C

month, the precipitation amount and duration, and the human-caused risk level. The NFDRS indexes and components are also totaled. This report may be used to chart the monthly progress of your fire season.

The **daily list** also provides a convenient way to learn how changing weather elements affect the fuel moistures and the NFDRS values. It is a complete statement of all that is known from a fire-danger point of view about any particular day, and it can provide information for fire reviews, trespass cases, arson investigations, and other studies when no other measurements were made.

Through the **daily list**, fire managers can also see sudden changes in the character of a particular element such as woody fuel moisture green-up. Note that before green-up on June 1 **(E)** the woody fuel moisture was held constant, and the herbaceous fuel moisture was the same as the 1-hour fuel moisture. At green-up the living fuel moistures begin to increase.

Summary of Station Statistics

The **summary of station statistics** (fig. 3) is printed after each year is processed. The usual heading appears at the top of the page with the title. The year **(A)** for which these data is being summarized is printed below the title. This printout summarizes the lightning fire occurrence indexes for the fire season **(B)** using a lightning scaling factor **(C)** specified on lead card two. The summary also illustrates the pattern of lightning activity level distribution **(D)**. These statistics are required to recalculate the lightning scaling factor for use with the AFFIRMS program. See Appendix D of Deeming *et al.* (1977) for a discussion of this analysis. FIRDAT reports how much data were missing from the official fire season **(E)** and the total number of days processed **(F)**.

The average ignition component is printed to help the fire manager appraise the local adjustment for human-caused fires **(G)** (see Deeming *et al.* 1977, Appendix E). If you have selected the **passing file** (a product of FIRDAT that passes data to SEASON and FIRINF), the total number of records written on it will be noted at the bottom of the final annual summary that you receive **(H)**.

Frequency Distributions Table

FIRDAT sorts all the days in a station's fire season from the lowest to the most extreme fire danger and prints out a **frequency distributions table** (fig. 4). On lead card one you select the indexes, components, and/or fuel moistures for tabulation. You will receive a table for each variable that you select. The table summarizes how often each level of that measure of fire danger occurred.

In our example, the burning index **(A)** was the chosen variable. Our table shows the total number of days (731) that fell within the fire season **(B)** and the total number of classes (26) into which the variable is divided **(C)**. To ensure that this table will fit on one page, FIRDAT limits the number of classes to 50. In our example, the BI could range from 0 to 100, so the routine automatically chose a step size of two **(D)**. The sequence is detailed in the upper boundary column.

The first column of this table shows class (or row) numbers. The first row of the table (CLASS NO. 1) gives the number of days with a BI of zero. (When it is raining, zero values are entered in the fire weather observation.) In this example, because the step size is 2, the second row (or CLASS NO. 2) includes days that had burning indexes of 1 and 2 with an upper boundary of 2 **(E)**. The next column (F) tells how many days were at those levels of the BI. The relative frequency column **(G)** indicates that the 12 days in row two make up 1.6 percent of the total number of days.

Many agencies use the cumulative frequency **(H)** as the basis for determining their adjective levels or manning classes. Cumulative frequency is the percent of all the days in the fire season that had as small a value as the one indicated in the upper boundary column. In row two, for example, 9.2 percent of the 731 days in the fire season had burning indexes of 2 or less. Often, fire managers determine their manning levels at two specific percentile values. You can specify these two values on lead card two. FIRDAT will use 90th and 97th percentiles **(I)** unless you enter different ones. Our example indicates that the BI has a value of 29 (28.61, rounded up), or less, 90 percent of the time in the fire season. Similarly, the fire manager would expect the BI to be below 35 (34.69, rounded up) at least 97 percent of the time. On the other 3 percent of the days, the burning index will exceed 35.

Frequency Distributions Graph

The points on the **frequency distributions graph** (fig. 5) are the cumulative frequencies listed in the last column of the **frequency distributions table**

1978 NFDRS VERSION FFY 2.5 SUMMARY OF STATION STATISTICS 22 JAN. 81 PAGE 36
KOOTENAI NF LIBBY MONTANA 240107 ELEVATION- 2070 LATITUDE-49
MODEL-C SLOPE CLASS-2 HERB TYPE-A CLIMATE CLASS-2 FIRE SEASON- 5/ 9 TO 9/ 9

1977 A

T O T A L OF LIGHTNING OCCURRENCE INDEXES FOR THE FIRE SEASON OF 5/ 9 - 9/ 9 LESS 0- 0 IS -- 560 B

WITH A LIGHTNING SCALING FACTOR OF 1.00 C

LIGHTNING ACTIVITY LEVEL DISTRIBUTION

LAL CLASS	NO IN CLASS	PCT FREQ	FREQUENCY DISTRIBUTION
1	56	45	**********
2	51	41	**********
3	12	10	*********
4	4	3	*** D
5	1	1	*
6	0	0	

W E A T H E R O B S S C O R E

YOU RECORDED WEATHER FOR A TOTAL OF 124 OUT OF A POSSIBLE 124 DAYS
DURING YOUR DEFINED FIRE SEASON. YOU L O S T 0 PERCENT OF YOUR DATA E

A TOTAL OF 213 DAYS WERE PROCESSED IN AND OUT OF THE FIRE SEASON. F

AVERAGE IGNITION COMPONENT FOR THE DEFINED FIRE SEASON IS -- 20 G

AT THIS POINT IN THE RUN 1096 RECORDS HAVE BEEN WRITTEN TO THE PASSING FILE. H

Figure 3.—*Summary of station statistics.*

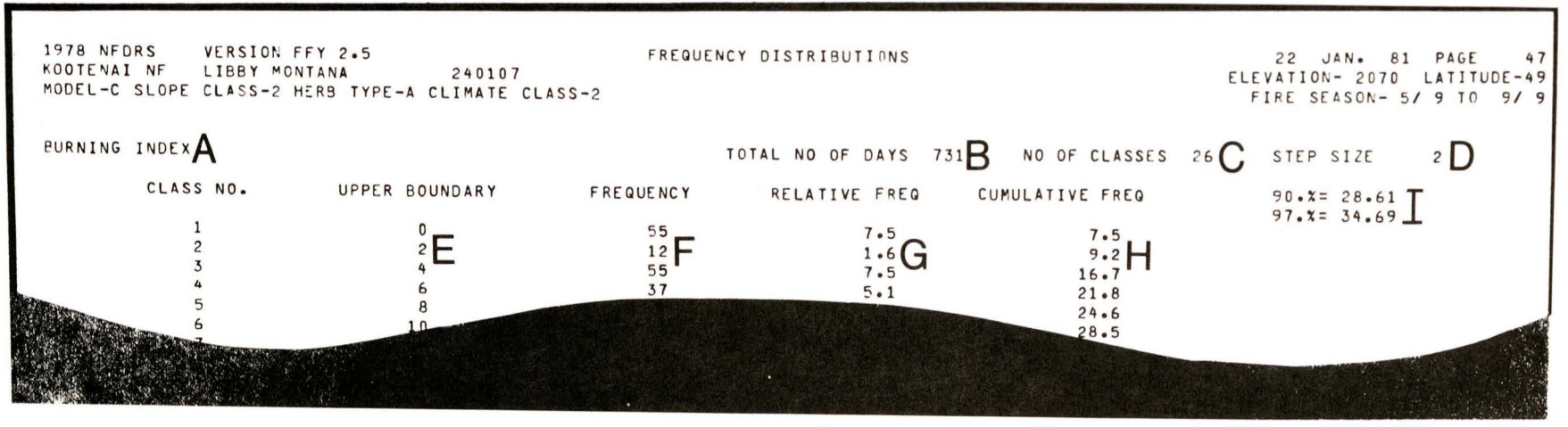

1978 NFDRS VERSION FFY 2.5
KOOTENAI NF LIBBY MONTANA 240107
MODEL-C SLOPE CLASS-2 HERB TYPE-A CLIMATE CLASS-2
FREQUENCY DISTRIBUTIONS
22 JAN. 81 PAGE 47
ELEVATION- 2070 LATITUDE-49
FIRE SEASON- 5/ 9 TO 9/ 9
BURNING INDEX A
TOTAL NO OF DAYS 731 B
NO OF CLASSES 26 C
STEP SIZE 2 D
90.%= 28.61
97.%= 34.69 I
CLASS NO.
UPPER BOUNDARY E
FREQUENCY F
RELATIVE FREQ G
CUMULATIVE FREQ H
1 0 55 7.5 7.5
2 2 12 1.6 9.2
3 4 55 7.5 16.7
4 6 37 5.1 21.8
5 8 24.6
6 10 28.5

Figure 4.—*Frequency distributions table.*

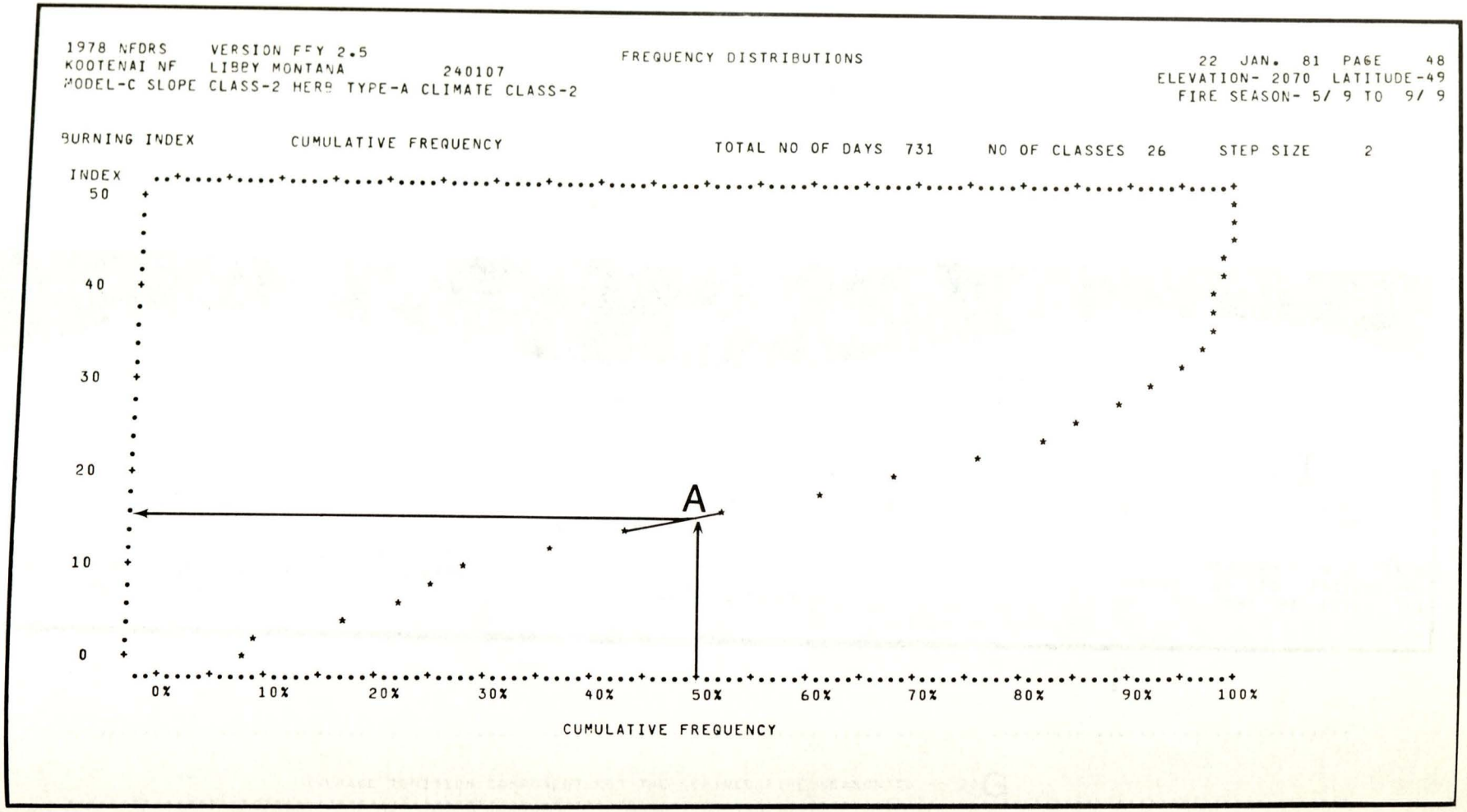


Figure 5.—*Frequency distributions graph.*

(fig. 4). This graph allows you to find the cumulative percentage of days in your fire season that are exceeded by any value of the chosen variable. In our example, the vertical line at the 50th percentile (**A**) intersects the **frequency distributions graph** near the BI of 16. Thus, on half of the days in the fire season the BI will be approximately 16 or less.

Manning Level Table

Frequency distributions are often used to determine agency manning levels. One method for calculating the upper boundaries for six manning levels is shown in table 1.[1] We used our **frequency distributions table** (fig. 4, **I**) to find the upper boundaries for the 90th and 97th percentiles of the BI. Then we divided the 90th percentile value (29) according to the formulas shown to obtain the upper boundaries of the other classes. Remember that the lower boundary of the lowest range is 0, but the upper boundary of the extreme range is limited only by the index or component selected.

Observed Weather Elements

FIREFAMILY allows you to request a printout of **observed weather elements** (fig. 6). (Note: choosing this feature will suppress all other FIREFAMILY features.) The column headings (**A**) are similar to those in the daily list, except that no fire-danger rating values are calculated or printed. This is the only FIREFAMILY listing that shows how the relative humidity was measured (**B**). In our example, RH indicates that relative humidity was measured directly, instead of being estimated from a wet-bulb or a dew point temperature. This printout is also the only one that shows the wind direction (**C**). Data fields that were not measured (**D**) are indicated with a "B."

FIRDAT Lead Card One

The information that the fire manager provides on the lead cards is vital to the success of FIREFAMILY routines. Every time FIREFAMILY is run, you must provide lead cards one and two. The options you choose will determine the results obtained as well as the costs of running the program.

[1]*See Appendix E of the AFFIRMS manual for an example of a 10-manning class table.*

Table 1.—*An example of a 6-level manning class table*

Manning class	Description	Burning index	Calculation formulas	Upper boundaries of manning classes
6	Extreme	36 +	Above the 97th percentile	(100 +)
5	Very high	30-35	97th percentile (from table)	35
4	High	23-29	90th percentile (from table)	29
3	High moderate	16-22	90th percentile/1.33 = 21.75	22
2	Low moderate	8-15	90th percentile/2 = 14.5	15
1	Low	0-7	90th percentile/4 = 7.25	7

NOTE: The lower boundary in each manning class is one more than the upper boundary of the next lowest class. Set the upper boundary of the extreme class high enough to accommodate the most extreme values of your variable.

You begin coding lead card one (Appendix Ia), by placing a 1 in the first card column. Then continue by coding with the administrative owner's name, station name and number, elevation in feet, and latitude. For example, KOOTENAI NF; LIBBY MONTANA; 240107; 2,070 feet; and 49° were coded in card columns 2-46.

Next, you must specify a model-slope-herb-climate combination. Ordinarily this will be the same combination you use for your daily weather observations. You should use all of the weather data available to you at the National Fire Weather Data Library. If you code 00 for the beginning of the range of years and 99 for the ending year in item 8, you will obtain output for all of your station's historic weather data.

FIRDAT allows you to specify the beginning and ending months and days of your fire season in item 9. Your fire season may begin in the fall and end in the spring or vice-versa. Note: You may skip over periods of low fire danger by specifying them on lead card two, item 6.

From now on, your selections on lead card one become crucial. For example, if you choose the variable or variables your agency uses for planning, your FIREFAMILY run will be more helpful. If you choose all the variables, you might generate excess paper. You may choose up to eight variables in item 10: ignition component, spread component, energy release, human-caused fire occurrence, lightning fire occurrence, burning index, fire load index, and/or fuel moistures. Code a "T" (true) in the appropriate column for each variable you want to see. Place an "F" (false) in the columns of the variables you don't want. If you code a "T" for fuel moistures, you will get all four: 1-hour, 10-hour, 100-hour, and 1,000-hour.

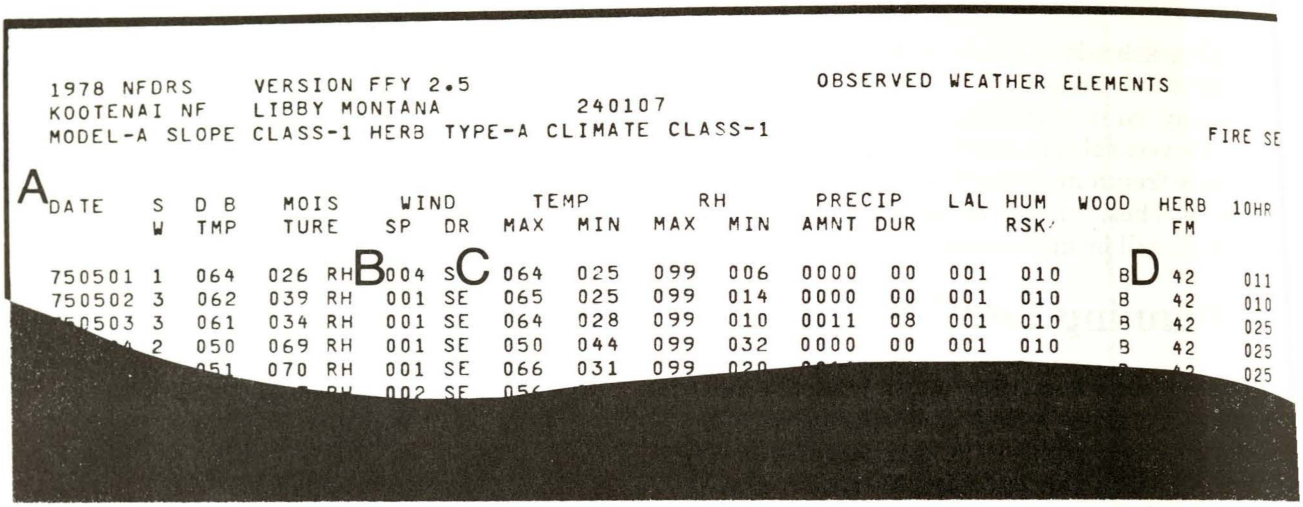


Figure 6.—*Observed weather elements.*

Next, you should decide if you wish to see the **daily list** of weather, components, and indexes. Place a "T" in column 71 to see the **daily list.** If you have already seen the **daily list**, placing an "F" in column 71 will save you money. Coding an "A" will be expensive, because it will cause the routine to print **daily lists** for all of the model-slope-herb-climate combinations that you select on lead card two.

The most important dollar-saving feature of FIREFAMILY is its ability to skip over FIRDAT when you have saved your **passing file** from a previous FIRDAT run. Code "T" in column 72 to skip FIRDAT and go directly to SEASON and/or FIRINF. Placing an "F" in column 72 will cause normal FIRDAT operation.

Placing a "T" in column 73 activates the weather-only feature (**observed weather elements**—fig. 6) of FIREFAMILY. Always place an "F" in column 73 unless you want only the raw weather data.

Placing a "T" in column 74 will cause the program to create a **passing file** (the file that passes information to SEASON and FIRINF). Because it is expensive to create the information on the **passing file**, you should save this file for later use with FIRINF and/or SEASON.

FIRDAT Lead Card Two

Lead card two (Appendix Ib) gives you other FIRDAT options. You can provide information about risk assessments, dates for green-up and curing, up to four combinations of model-slope-herb-climate, and you may specify a split fire season. If you are going to run SEASON and FIRINF together with FIRDAT, you may choose one index or component to determine your manning levels. You may also redefine the per boundaries of your manning percentiles on le card two.

If you don't know your lightning risk scaling fa tor (LRS), use the value 01.00 in columns 2-6 of le card two. If you run FIRDAT again, you should co sult Deeming *et al.* (1977, Appendix D) to revie guidelines for computing the lightning risk scalin factor. (See fig. 3, **B**, to find the total of lightnin occurrence indexes in our example.)

You must provide estimates on lead card two fo weekday and weekend human risk. The weekda (W) and weekend (E) values may range from 0 t 100 and should be recorded in columns 7-9 and 10 12.

Next, select the month and day when herbaceou plants usually start to green-up at your station. Cod the month in card columns 13-14 and the day in 15 16. (Key abbreviation for green-up on lead card tw in fig. 1 is GU.) Continue by specifying the earlies month and day on which you expect fall curing t begin. Herbaceous plants will not necessarily die o this day; instead FIRDAT begins to look for weathe conditions that indicate freezing. If, for instance, hard frost occurs with a minimum temperature 25° or less, the NFDRS will "cure" the herbaceou fuels immediately. If no hard frost occurs, FIRDA automatically records curing and dormancy after th fifth day with a minimum temperature of less tha 33°. If minimum temperatures were not observed f your station, the date you specified in columns 1 20 will be used as the curing date. If your area nev experiences freezing, enter 1232 in columns 17-2

Because of diverse fuel types and topography, you might want to process your data with more than one combination of model, slope, herbaceous class, and climate. If so, indicate as many as four additional combinations in card columns 21-36. For example, if you have two different forest types near your weather station, you could process the data for upland hardwood stands (NFDRS Model E) and, with the same set of lead cards, process the conifer types (NFDRS Model H). If, on lead card two, you change your climate class or herbaceous code, you may have to use a new lead card one to redefine the green-up and curing dates.

Many parts of the country have a two-part fire season. The Southeast, for example, has a fall season of October and November and a spring season of February to April. With that pattern, running cumulative frequencies for dates of October to April will include the 2 months of low fire occurrence (December-January), thereby biasing the results. To avoid this bias, skip the low risk period by coding its beginning month in columns 37-38, the beginning day in columns 39-40, the ending month in columns 41-42, and the ending day in columns 43-44. If you do not have a split fire season, leave these columns blank.

The first time you use FIREFAMILY, you should run FIRDAT by itself, saving the **passing file**. You can then analyze the FIRDAT cumulative frequency tables to find the index values necessary to calculate your manning classes. If you want to include SEASON and/or FIRINF in the first run, FIRDAT provides an option that calculates a set of ranges for one index. Choose the number of the variable (1-7) from the list in item 7 and code it in card column 45 (see Appendix Ib). This code will cause FIRDAT to calculate the ranges that will become the rows and/or columns for your SEASON and FIRINF tables. **However, we strongly recommend that you do not attempt to run SEASON or FIRINF in the first run with FIRDAT.**

The USDA Forest Service uses the 90th and 97th percentiles to delineate the high and very high manning levels. If your agency uses other values, you should enter them in columns 46-47 and 48-49 on lead card two.

SEASON ROUTINE

The severity of fire weather changes during the year. The SEASON routine summarizes these variations and reveals seasonal patterns over many years to help fire managers plan. SEASON will tabulate and/or graph the values of any of the fuel moistures, indexes, or components the fire manager wishes to analyze.

SEASON has three major sections: **seasonal tables** and **graphs**, monthly **persistence probability tables**, and the cumulative **BI seasonal severity list** and **summary table.** The **seasonal tables** show the average, highest, and lowest values of the chosen variable for each day of the year. **Seasonal graphs** map the general character of the fire season shown in the **seasonal tables**. The **persistence probability tables** report the chance that tomorrow's variable will be the same as today's. The **BI seasonal severity summary table** ranks the fire seasons of each year according to their difficulty, based on the 90th percentile of the burning index. Remember that BI severity measures only the effect of weather, not fire activity.

Seasonal Table

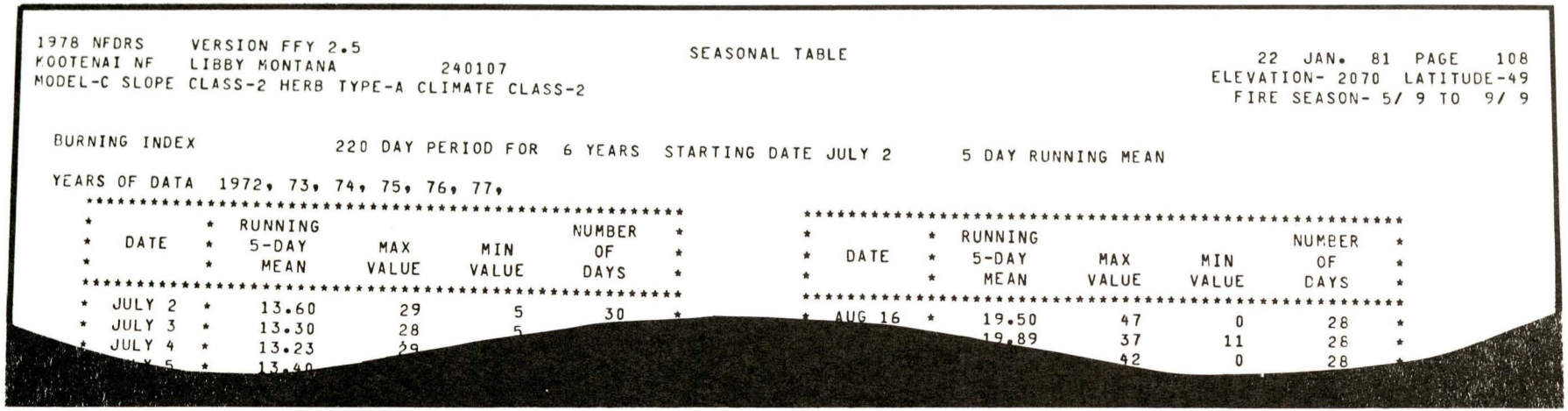
The **seasonal table** shows—for each variable you select—the mean, maximum, and minimum values for the averaging period as well as the number of weather observations recorded over the period of years indicated at the top of the table (fig. 7). All the observed data are included in the **seasonal table**, not just the data from the fire season. To save money and paper, choose only the variable(s) most important for planning.

In figure 7, we chose the BI. We also selected an averaging period of 5 days. This running mean is an average calculated from an odd number of consecutive days, centered on the observation date. The longer the period chosen for the running mean, the smaller the day-to-day changes in the average will be. This "smoothing" of the daily averages will make a graph of this information easier to interpret. Smoothing periods of 3 to 7 days are usual.

Graphing Options

SEASON provides the option for graphing the tabulated information in figure 7. If you ask for such a graph (Appendix Ic, card column 10 = T), you will get one page of printout for every 2 months shown in the table. You will also receive a graph legend that explains symbols used, years included, and the scale the computer selected to lay out the graph.

SEASON can also graph the data 1 day at a time, year after year. This feature might give you insight into a particularly bad year or show how drought affects out-of-season wildfires. **Be careful, however, because this feature can generate massive volumes of paper**. To save paper and money, select



1978 NFDRS VERSION FFY 2.5
KOOTENAI NF LIBBY MONTANA 240107
MODEL-C SLOPE CLASS-2 HERB TYPE-A CLIMATE CLASS-2

SEASONAL TABLE

22 JAN. 81 PAGE 108
ELEVATION- 2070 LATITUDE-49
FIRE SEASON- 5/ 9 TO 9/ 9

BURNING INDEX 220 DAY PERIOD FOR 6 YEARS STARTING DATE JULY 2 5 DAY RUNNING MEAN

YEARS OF DATA 1972, 73, 74, 75, 76, 77,

DATE	RUNNING 5-DAY MEAN	MAX VALUE	MIN VALUE	NUMBER OF DAYS
JULY 2	13.60	29	5	30
JULY 3	13.30	28	5	
JULY 4	13.23	29		
[illegible] 5	13.40			

DATE	RUNNING 5-DAY MEAN	MAX VALUE	MIN VALUE	NUMBER OF DAYS
AUG 16	19.50	47	0	28
	19.89	37	11	28
		42	0	28

Figure 7.—*Seasonal table.*

the variable or variables of greatest concern (columns 3-9, Appendix Ic), use the combination of model-slope-herb-climate on lead card one only, and turn off the SEASON tables (column 11 = F). To activate this **single year graph** feature, code column 14, lead card 3, with a "T."

Fire Manager's Graph

You can easily hand draw a graph of your own data. Figure 8 is a graph of the seasonal variations of the BI. We used graph paper that already included a year-by-day legend along the bottom. To find the range of the variable which we were plotting, we consulted our **frequency distributions table** (fig. 4). Because the BI ranges from 0 to 50, we used that range for our vertical scale. The **frequency distributions table** also gives the upper boundaries of the 90th and 97th percentiles. We used these values as well as the information contained in table 1 to draw five horizontal manning class lines. Bold **A** (fig. 8) shows that we drew the line for the upper boundary of our 90th percentile at a BI of 29 (28.61, rounded up).

Next, we transferred the daily mean values from the **seasonal table** (fig. 7) to the graph and connected them with a smooth line. (We used a running mean of 5 days to smooth our curve.) This curve shows the seasonal variation in the burning index. Finally, we drew vertical lines at the beginning **(B)** and end **(C)** of our fire season.

You could also plot your daily maximum and minimum values from the **seasonal table**. Once you have graphed your historical weather curve, you can use this graph to compare your current daily values with the averages. Lay a clear plastic sheet over your historical graph and plot current observed values on it.

If you asked for the computer printed graphs of the **seasonal tables**, you could draw the manning levels and the seasonal curve on them, but it would be difficult to overlay a plastic sheet on such a large graph.

Persistence Probability Table

Persistence measures how likely something is to remain the same. The fraction of the time that the weather will be the same tomorrow as it is today is tabulated in the SEASON's **persistence probability table** (fig. 9). The higher the persistence, the less likely the weather will change. SEASON produces monthly **persistence probability tables** for the chosen variable.

Information at the top of the table indicates the total number of years, the month for which data are being tabulated, and the specific years included. One page of output will be produced for each month of data. In our example, the burning index is divided into six manning classes (table 1). These six classes make up both the row and column headings in each of the three parts of figure 9. Today's BI's are found in the rows **(A)** and tomorrow's BI's are found in the columns **(B)**. The ranges illustrated in the **persistence probability table** were computed by FIRDAT. However, you can select them by coding on lead card three (see Appendix Ic, item 9).

The **persistence probability table** reports the total number of pairs of days that were found **(C)**. (A pair occurs whenever there are weather observations on 2 consecutive days.) Out of a possible 186 pairs (31 days x 6 years), 175 pairs were found. The greatest number of pairs occurred when the BI was in the 16-22 class 1 day and continued in the same class through the next day 38 times **(D)**.

Figure 9 is divided into three parts. The top third tells how many times each pair of BI 's (today's and tomorrow's) falls within each of the manning class ranges (both rows and columns). In our example, **E** shows that the BI was in the extreme range 2 days in a row (both today and tomorrow) four times in the 6 years under study.

The middle third tells what percentage of the time a BI today was followed by each of the BI ranges tomorrow. The bottom row of the middle section **(F)** shows that if our BI is 36-50 today, then 45 percent (45.45) of the time tomorrow's BI will be in the 23-29 range. The chance that today will be followed by the next range (30-35) is 18 percent. Finally, the chance that the BI tomorrow will be in the same range as it is today is 36 percent. The fire manager would use this section of the table to predict the range of tomorrow's burning index by today's BI. The fire manager would want to pay particular attention to very high or extreme conditions. As the previous example showed, if the BI is in the extreme range today, the chances are about one in three (36 percent) that tomorrow's BI will also be in the extreme range. These historic data is used primarily for planning how long to keep firefighters ready to handle the worst fires.

The bottom third of the figure indicates the percentage of the time that any particular combination of today's and tomorrow's values occurs. For example, the occurrence of extreme days following one another **(G)** is only 2.29 percent of the time in August. This means that the fire organization should

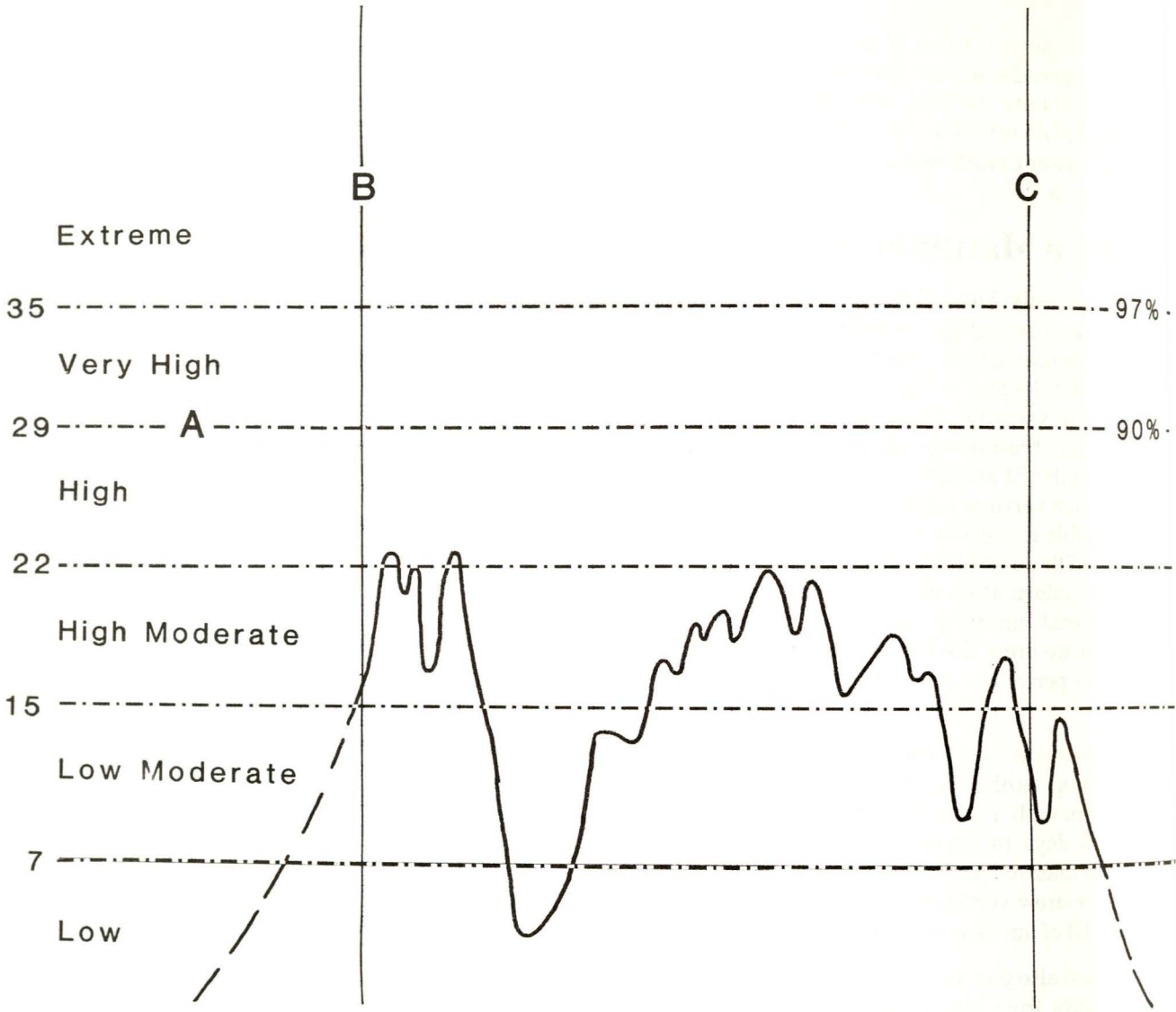


Figure 8.—*Fire manager's hand-drawn seasonal graph of the BI.*

plan to have 2 of their worst days back-to-back about once each August (2.29 percent of 31 days in August = 0.71 days, or about once every August).

Note: If you want to see your persistence probability, **don't** turn on the **single year graph** feature in SEASON.

BI Seasonal Severity

The seasonal severity routine uses the burning index to rank how severe the fire weather was each year. Seasonal severity both lists those days that have a BI exceeding the 90th percentile and summarizes the data by months and year.

BI Seasonal Severity List

The **BI seasonal severity list** (fig. 10) ranks each year at a fire weather station in terms of the burning index. The ranking takes into account both how often and by how much each day's BI exceeded the 90th percentile BI level. The column headings (**A**) identify the dates that exceeded the 90th percentile BI, the BI value on these dates, the cumulative departures and finally, the number of days in that year that the BI exceeded the 90th percentile BI. The program shows the upper boundary of the 90th percentile BI (90% = 29) (**B**).

We see that the first day in 1972 to exceed the 90th percentile value was May 19. The difference

1978 NFDRS VERSION FFY 2.5 PERSISTENCE PROBABILITY
KOOTENAI NF LIBBY MONTANA 240107
MODEL-C SLOPE CLASS-2 HERB TYPE-A CLIMATE CLASS-2

--PERSISTENCE-- 6 YEARS OF DATA FOR AUG

YEARS OF DATA 1972, 73, 74, 75, 76, 77,

TOMORROWS BURNING INDEX (AUG) C 175 PAIRS

TODAYS BURNING	B 0- 7	8- 15	16- 22	23- 29	30- 35	36- 50
A 0 - 7	9	8	4	0	0	0
8 - 15	8	20	6	1	0	0
16 - 22	2	8	38 D	10	3	0
23 - 29	1	1	8	14	6	2
30 - 35	1	0	4	2	3	5
36 - 50	0	0	0	5	2	4 E
0 - 7	42.86	38.10	19.05	.00	.00	.00
8 - 15	22.86	57.14	17.14	2.86	.00	.00
16 - 22	3.28	13.11	62.30	16.39	4.92	.00
23 - 29	3.13	3.13	25.00	43.75	18.75	6.25
30 - 35	6.67	.00	26.67	13.33	20.00	33.33
36 - 50	.00	.00	.00	45.45 F	18.18	36.36
0 - 7	5.14	4.57	2.29	.00	.00	.00
8 - 15	4.57	11.43	3.43	.57	.00	.00
16 - 22	1.14	4.57	21.71	5.71	1.71	.00
23 - 29	.57	.57	4.57	8.00	3.43	1.14
30 - 35	.57	.00	2.29	1.14	1.71	2.86
36 - 50	.00	.00	.00	2.86	1.14	2.29 G

Figure 9.—*Persistence probability table.*

(31–29 = 2) was entered in the cumulative departure column. The cumulative departure totals the daily departures (Daily departures = $BI_{today} - BI_{90percentile}$). The August 11 daily departure (31–29 = 2) was added to the previous two cumulative departure points to equal four cumulative departure points and so on.

Our example also shows the beginning of the 1973 fire season **(C)** where we note 7 days in a row exceeding the 90th percentile BI. Such periods would force a fire suppression group to respond day after day at its maximum strength.

BI Seasonal Severity Summary Table

The data in the **BI seasonal severity list** are summarized in the **BI seasonal severity summary table** (fig. 11). The months **(A)** are listed horizontally above the summarized information. The cumulative departures and the number of days above the 90th percentile value for all the months are tabulated **(B)**. Both the total departures and the day counts **(C)** indicate that 1973 was about 14 times more severe than average. The annual ratings for 1973 **(D)** show

1978 NFDRS VERSION FFY 2.5 BI SEASONAL SEVERITY LIST
KOOTENAI NF LIBBY MONTANA 240107
MODEL-C SLOPE CLASS-2 HERB TYPE-A CLIMATE CLASS-2

CUMULATIVE BI SEVERITY

A

DATE	BI VALUE	CUMULATIVE DEPARTURE	NUMBER OF DAYS
72 515	31	2	1
72 811	31	4	2
72 829	33	8	3
72 830	35	14	4
7210 3	33	18	5
7210 5	32	21	6
7210 7	31	23	7
73 515	31	2	1
73 516	46	19	2
73 517	34	24	3
73 518	34	29	4
73 519	50	50	5
73 520	31	52	6
73 521	33	56	7
73 531	32	59	8
[illegible]	31	61	9
		71	10

B 90%= 29 (VALUE MAY BE CALCULATED OR SET.)

C

Figure 10.—*BI seasonal severity list.*

1978 NFDRS VERSION FFY 2.5 BI SEASONAL SEVERITY SUMMARY 22 JAN. 81 PAGE 61
KOOTENAI NF LIBBY MONTANA 240107 ELEVATION- 2070 LATITUDE-49
MODEL-C SLOPE CLASS-2 HERB TYPE-A CLIMATE CLASS-2 FIRE SEASON- 5/ 9 TO 9/ 9

THESE SEVERITY RATINGS ARE BASED ON AVERAGE DATA, NOT USER SUPPLIED. BI(90%)= 29

A

YEAR	JAN DEP-DY	FEB DEP-DY	MARCH DEP-DY	APRIL DEP-DY	MAY DEP-DY	JUNE DEP-DY	JULY DEP-DY	AUG DEP-DY	SEPT DEP-DY	OCT DEP-DY	NOV DEP-DY	DEC DEP-DY	TOTALS DEP-DY	RATINGS BI	DAY	BI X DAY
1972	0- 0	0- 0	0- 0	0- 0	2- 1	2- 1	2- 1	14- 4	14- 4	23- 7	23- 7	23- 7	23- 7	.317	.568	.180
1973	0- 0	0- 0	0- 0	0- 0	59- 8	61- 9	106-19	262-39	288-45	288-45	288-45	288-45	288- 45	3.963	3.649	14.461
1974	0- 0	0- 0	0- 0	0- 0	22- 3	22- 3	22- 3	22- 3	41- 4	41- 4	41- 4	41- 4	41- 4	.564	.324	.183
1975	0- 0	0- 0	0- 0	0- 0	0- 0	0- 0	0- 0	0- 0	0- 0	0- 0	0- 0	0- 0	0- 0	.000	.000	.000
1976	0- 0	0- 0	0- 0	0- 0	4- 1	4- 1	4- 1	4- 1	4- 1	4- 1	4- 1	4- 1	4- 1	.055	.081	.004
1977	0- 0	0- 0	0- 0	3- 2	3- 2	22- 5	72-14	80-17	80-17	80-17	80-17	80-17	80- 17	1.101	1.378	1.517
TOTAL													436- 74			
AVRGE= YEARS= 6	0- 0	0- 0	0- 0	0- 0	14- 2	3- 0	15- 3	29- 4	7- 1	1- 0	0- 0	0- 0	72-7		12.33	

B C D E F G

that the total departures were 3.963 times greater than the average. Similarly the ratings day **(E)** shows that there were 3.649 more days above the 90th percentile than normally occur. The product of the BI and day columns **(F)** for 1973 is 14.461. The average annual departure and number of days are reported at (G). Our example shows that in these 6 years, the average BI departure was 72.7 and the average number of days above the 90th percentile was 12.33. Because the station has a 123-day fire season, we expected about 10 percent of the days to exceed the 90th percentile level.

Remember that this method evaluates the weather of each year, not wildfire activity.

SEASON Lead Card Three

Appendix Ic describes the coding necessary for the SEASON routine. Coding a 3 in card column 1 (item 1) identifies a SEASON lead card. SEASON can plot the NFDRS components and indexes (item 3, list 1), the weather elements (item 3, list 2), or the living and dead fuel moistures (item 3, list 3). You choose the list you want by coding the number 1, 2, or 3 in card column 2. Then from that list select the variables that you want tabulated or graphed. You **must** select one list and at least one variable or SEASON will not function. Leave the card column blank for every variable you don't want tabulated or graphed.

You may select **seasonal graphs, tables**, or both by coding a "T" or "F" in columns 10 and 11 (items 4 and 5). The averaging period for graphs and tables (columns 12-13) must be an odd number between 01 and 31 (item 6). If you choose 1 day, a jagged graph will result. Increasing the averaging period will "smooth" the graph (see fig. 8 for an example). Use 3, 5, or 7 days as your running mean for a "smoothed" graph.

If you want a graph of individual years, code "T" in column 14 (item 7). Because this feature has limited value, you will usually code "F." Note well: The single **year graph feature** automatically turns off **BI seasonal severity list** and **summary table** and **persistence probability tables**. It may also create excessive paper and expense (see Appendix II, item 7).

If you don't wish to receive a **persistence probability table**, enter a 0 in column 15, item 8. To get a **persistence probability table**, however, you must choose one of the indexes or components from item 3 that you coded in columns 3-9. Code the number of the variable in column 15. (In our example in fig. 9, we had coded list number 1 in card column 2 and coded 6 in column 8, so we could again code 6—the burning index—in card column 15.)

You will usually run FIRDAT first, analyze the data, and then run SEASON. (SEASON will get all its weather data from the **passing file**.) As part of this analysis, you will find the 90th and 97th percentile values of your variable on your **frequency distributions table** (fig. 4, I). Item 9 tells you to code your upper boundary levels in columns 16-33 on lead card three. In our example (table 1), we would code 007 in columns 16-18, 015 in columns 19-21, and so on.

You can force FIRDAT to compute the upper boundaries of the variable chosen in item 8 by running FIRDAT and SEASON at the same time and placing the number of the variable from the list in item 3 into column 45 on lead card two. The computer will then automatically calculate the upper and lower boundaries and you need not fill in columns 16-33 in item 9 on lead card three.

You may have the **BI seasonal severity list** and **summary table** printed by placing a "T" in column 34 (item 10). If this SEASON run immediately follows a FIRDAT run, SEASON will remember the 90th percentile value of the BI, so leave item 11 blank. However, if you run SEASON independently with the **passing file**, then you must specify the 90th percentile BI in columns 35-37.

The **BI seasonal severity summary table** (fig. 11) can be produced in two ways. If this is a run with FIRDAT, you should leave columns 38-47 blank. The routine will calculate the average departure points and number of days and print them (fig. 11, G). Later, you may wish to compare the BI seasonal severity with different average values for the departures and number of days. You can instruct the routine to use these values by placing them in card columns 38-47. In our example, the columns on lead card three were left blank and the computer determined the average values.

FIRINF ROUTINE

Although SEASON deals with only one NFDRS variable at a time, FIRINF can provide information on combinations of two variables. Many agencies combine two variables to determine their adjective or manning classes. For example, fire managers often combine the IC (a measure of fire occurrence) with the BI (a measure of fire intensity) to determine these classes. They could then use these FIRINF tables for planning detection flights, wildfire prevention activities, industrial closures, and specific action guides. Both SEASON and FIRINF get their data from the **passing file** produced by FIRDAT. The FIRINF routine uses only the first 3,600 days of historical weather

data, so you may wish to decide which 10 years are most important to you and code them on a new lead card one (see Appendix Ia, item 8).

Adjective Class Matrix

The **adjective class matrix** (fig. 12) is one of the most frequently used fire management tools. It combines the IC with the agency's manning class index or component to help provide the public with fire-danger levels.

Figure 12 demonstrates how the BI was used to provide the manning levels. The values FIREFAMILY computed for you or that you entered on lead card four (Appendix Id) are displayed at **A** in figure 12. The first pair of "x values" **(B)** shown (0-20) defines the boundaries of the first column. Each subsequent pair defines another column. The **adjective class matrix** always includes the same five ranges of the ignition component. The first "y value" pair (0-7) defines the first row of the BI. The other pairs define the remaining rows.

In figure 12, the row with a BI of 23-25 shows two "M's" (moderate), two "H's" (high), and a "V" (very high) in the columns from left to right. Other symbols found in the matrix are "L" (low) and "E" (extreme). A summary of the number of days in the data base and the number of days actually used is shown at the bottom of the printout.

This table provides the fire manager with a quick overview of how the IC and BI together affect the adjective class levels. For clarity we have outlined the area of the table containing the very high and extreme days **(C)**.

Instead of the **adjective class matrix**, you can obtain the **precautions class matrix**, a similar table often used to determine forest closures. The **precautions class matrix** uses a different range of column headings for the IC and allows the user to choose the variable (often the energy release component or the BI) to determine the manning levels.

FIRINF also provides you with an opportunity to form your own matrix to give you more information than that offered in either the **adjective** or **precautions class matrices**. You may combine any two of the seven variables listed on lead card four to produce the user-defined matrix. You may have to use a second or third lead card four for this purpose. Place "F's" in columns 2 and 3. Code the first variable number in column 4 and the second in column 35 and specify up to 10 upper boundaries of each index or component in the provided card columns (see Appendix Id).

Adjective Class Calendar

The **adjective class calendar** (fig. 13) indicates the adjective levels assigned by the **adjective class matrix** to each day for which you have historical weather data. **Precautions class** or **user-defined matrices** also produce a similar calendar.

FIRINF prints out the date (year—72, month—08, day—09) **(A)**. A dot (.) is printed above the first digit of the year. (Notice that the dates are printed below one another in groups of seven, indenting one column each time.) The adjective class letter (M—moderate) for the first date is printed in the row labeled M. (A row is provided for each class—L, M, H, V, E.) You can easily see the changes in adjective levels on a daily basis.

Find August 30, 1972 in the calendar **(B)**. Using a straight edge, draw a line up from the 7 (the first digit of the year) beyond its dot through the letter H **(C)**. Use this method to find the adjective rating for any day in your data base. In general, you will look at your calendar for repeated very high (V) or extreme (E) days. The **adjective class calendar** graphically illustrates persistence of adjective levels. In the **precautions class** and **user-defined matrices**, the letters A, B, C, D, E, and F are used to show class categories. "A" is the lowest level of fire danger.

Probability Analysis

Once you have asked for the **adjective class matrix**, you will get an **adjective class calendar** as well as monthly and annual **probability analysis tables**. These **probability analysis tables** will provide you with some of the detailed information necessary to plan your fire management activities. The tables will show how often you can expect values of your adjective class to occur. In figure 14, the table rows indicate the ranges of numerical values for the BI and the columns indicate the ranges of the ignition component.

The **probability analysis table** is divided into three parts. The top third **(A)** tells how often combinations of the BI and the IC occurred. Our example shows that in the six Augusts for which we have data, there were 17 days when the BI was 19-22 and the IC was in the range of 0-20. On 21 other days, when the BI was 19-22 the IC was in the range of 21-45.

The middle of the table **(B)** tells the percent of the time that the ignition component is in each column, given that the BI is in a particular row. For example, in the BI row labeled 19-22 we see that 44.74 percent

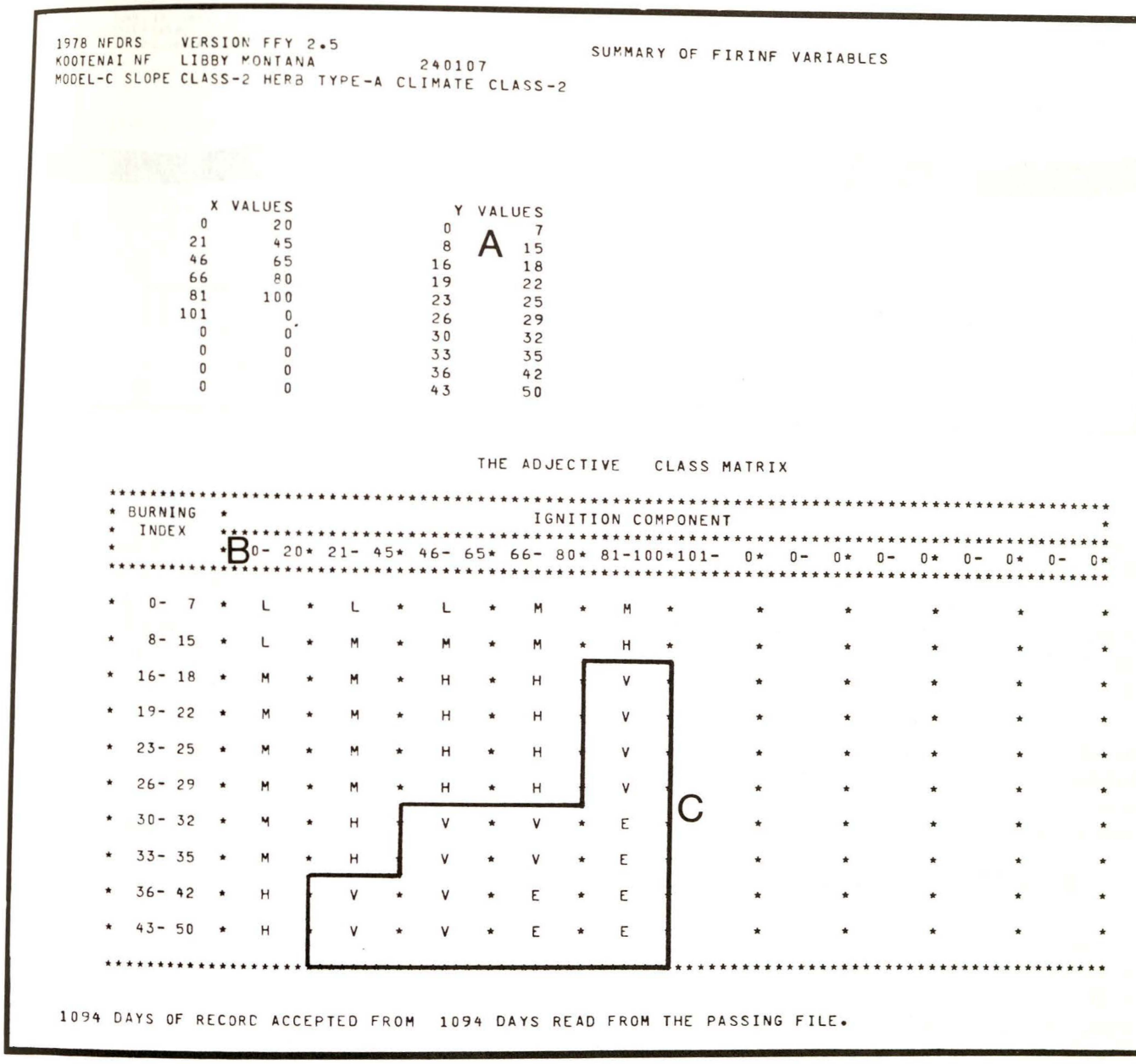


Figure 12.—*Adjective class matrix.*

of the time the ignition component was in the range 0-20 and 55.26 percent of the time the ignition component was in the 21-45 range.

The lower third of the table (**C**) tells the percentage of all the days on which each combination of the BI and IC occurred. Thus in our example, on 9.29 percent of all the August days, the BI was in the range of 19-22 and the ignition component had a value between 0-20. Similarly, on 11.48 percent of the days, the BI was between 19 and 22, and the ignition component ranged from 21-45.

Probability analysis tables are helpful to fire managers using historical weather data for planning and budgeting. On figure 12 we outlined the area of the table containing the very high and extreme days. We have used the same rows and columns to outline the identical portion of figure 14 (**D**). Adding all of the percentages within the outlined area, we find that a total of 7.65 percent of the 186 August days were in the very high or extreme range in the past (31 August days x 0.0765 = 2.37—or more than 2 days per August). Therefore, the fire manager would

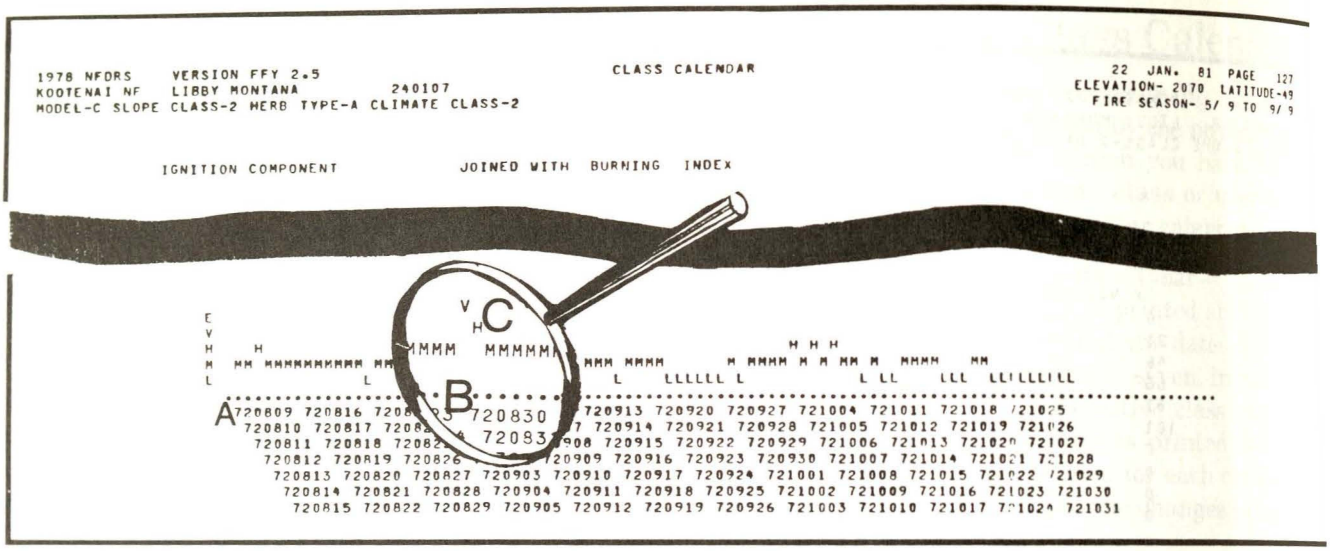


Figure 13.—*Adjective class calendar.*

budget for an average of 3 very high and/or extreme days in August each year.

In addition to the monthly **probability analysis tables**, you will receive a yearly **probability analysis table** showing the same kind of information, on an annual basis.

If you ask for a **precautions class** or **user-defined matrix**, you will receive **probability analysis tables** for them also. You can analyze them in the same way that you analyzed the **probability analysis table** for adjective classes.

FIRINF Lead Card Four

Two examples of the FIRINF lead card are shown at the bottom of the FIREFAMILY header page (fig. 1, **D**). A "4" punched in card column 1 (Appendix Id, item 1) identifies each FIRINF card. Item 2, Appendix Id, allows the user to select or reject the **adjective class matrix** by coding a "T" (true) or an "F" (false) in card column 2. If you run FIRDAT and FIRINF at the same time and you code a "6" in card column 45 of lead card two, FIRDAT will then compute the upper boundaries of your BI. Because the computer will then automatically provide the ranges of the BI, you need not fill in the rest of lead card four. When requesting the **adjective class matrix**, you must code an "F" in column 3 of lead card four. You can leave card column 4 blank because the IC is always used in the **adjective class matrix**. Both columns 2 and 3 may be coded false.

Usually you will be running FIRINF with a previously created **passing file**. The program will compute the upper boundaries of the IC for you, so leave columns 4-34 blank. But you must code the number of the variable you want combined with the IC into card column 35. Use our table 1 or Appendix E of the AFFIRMS manual to find a method to determine up to 10 upper boundaries of your chosen variable. Enter these boundaries in card columns 36-65.

A similar table to the **adjective class matrix**—the **precautions class matrix**—can be selected by coding an "F" in card column 2 and a "T" in card column 3. Just as for the **adjective class matrix**, if you are running FIRINF with FIRDAT and code number 3 (ERC) in card column 45 of lead card two, FIRDAT will provide the row ranges, so you can leave the rest of lead card four blank. If you have run FIRDAT previously, however, follow the coding routine suggested for the **adjective class matrix**, but use the ERC, the BI, or another variable for the rows.

Instead of selecting either the **adjective** or **precautions class matrices**, you can construct any other table by combining two variables from the list in Appendix Id, item 4. You might wish to construct your own table because your agency does not use the same method for determining manning levels that has been provided by FIRINF, or you may wish to choose indexes or components other than those provided by FIRINF. Code as follows: put the code number of your chosen column variable in card column 4 and the row variable in column 35. Constructing tables this way requires you to enter up to 10 of the upper boundaries for the ranges of the chosen variables. These numbers will appear in the columns and rows on the table you are constructing. Enter upper boundaries for the first variable in card col-

1978 NFDRS VERSION FFY 2.5 PROBABILITY ANALYSIS
KOOTENAI NF LIBBY MONTANA 240107
MODEL-C SLOPE CLASS-2 HERB TYPE-A CLIMATE CLASS-2

IGNITION COMPONENT VERSUS BURNING INDEX

	BURNING INDEX	IGNITION COMPONENT 0- 20	21- 45	46- 65	66- 80	81-100	101- 0
A	0- 7	23	0	0	0	0	0
	8- 15	37	1	0	0	0	0
	16- 18	21	5	0	0	0	0
	19- 22	17	21	0	0	0	0
	23- 25	1	15	0	0	0	0
	26- 29	0	16	0	0	0	0
	30- 32	0	7	1	0	0	0
	33- 35	0	5	2	0	0	0
	36- 42	0	3	5	0	0	0
	43- 50	0	0	1	2	0	0
B	0- 7	100.00	.00	.00	.00	.00	.00
	8- 15	97.37	2.63	.00	.00	.00	.00
	16- 18	80.77	19.23	.00	.00	.00	.00
	19- 22	44.74	55.26	.00	.00	.00	.00
	23- 25	6.25	93.75	.00	.00	.00	.00
	26- 29	.00	100.00	.00	.00	.00	.00
	30- 32	.00	87.50	12.50	.00	.00	.00
	33- 35	.00	71.43	28.57	.00	.00	.00
	36- 42	.00	37.50	62.50	.00	.00	.00
	43- 50	.00	.00	33.33	66.67	.00	.00
C	0- 7	12.57	.00	.00	.00	.00	.00
	8- 15	20.22	.55	.00	.00	.00	.00
	16- 18	11.48	2.73	.00	.00	.00	.00
	19- 22	9.29	11.48	.00	.00	.00	.00
	23- 25	.55	8.20	.00	.00	.00	.00
	26- 29	.00	8.74	.00	.00	.00	.00
	30- 32	.00	3.83	.55	.00	.00	.00
	33- 35	.00	2.73	1.09	.00	.00	.00
	36- 42	.00	1.64	2.73	.00	.00	.00
	43- 50	.00	.00	.55	1.09	.00	.00

D

Figure 14.—*Probability analysis table.*

umns 5-34, leaving any unused columns blank. Choose up to 10 upper boundaries for the second variable and code these numbers in columns 36-65 (item 7).

CONCLUSION

We have shown how your historical weather data can be combined with the NFDRS to produce a variety of useful planning tools. The **frequency distributions tables** indicate the highest fire-danger levels of each index or component. The SEASON printouts show when to expect periods of sustained high fire danger. Indexes and components are combined in the **adjective** and **precautions class matrices** to provide both the public and private sectors with estimates of potential fire danger.

Now that you have seen what FIREFAMILY can do for you, your next step is to determine what your needs are and submit the appropriate lead cards to your computer specialist. (You can photocopy the lead cards in Appendix I to make coding simpler.) The specialist will then combine your lead cards with the Fort Collins job-control cards shown in Appendix III.

ACKNOWLEDGMENTS

FIREFAMILY began as a collection of separate programs written by several people. The authors gratefully acknowledge R. William Furman and David Rainey, Rocky Mountain Station, Fort Collins, Colorado, for their early contributions to FIREFAMILY. We also thank Roger L. Bradshaw, Boise Interagency Fire Center, for his patience and help in the most recent refining of the program.

LITERATURE CITED

Burgan, Robert E.; Cohen, Jack D.; Deeming, John E. Manually calculating fire-danger ratings—1978 National Fire-Danger Rating System. Gen. Tech. Rep. INT-40. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1979; 51 p.

Deeming, John E.; Burgan, Robert E.; Cohen, D. The National Fire-Danger Rating Syst 1978. Gen. Tech. Rep. INT-39. Ogden, UT: Department of Agriculture, Forest Service, I mountain Forest and Range Experiment Sta 1977; 63 p.

Furman, R. William; Brink, Glenn E. The Nati Fire Weather Data Library: What is it and to use it. Gen. Tech. Rep. RM-19. Fort Collins. U.S. Department of Agriculture, Forest Ser Rocky Mountain Forest and Range Experir Station; 1975; 8 p.

Helfman, Robert S., Straub, Robert J.; Deeming, J E. User's guide to AFFIRMS: Time-share c puterized processing for fire danger rating. G Tech. Rep. INT-82. Ogden, UT: U.S. Departm of Agriculture, Forest Service, Intermountain F est and Range Experiment Station; 1980. 150

APPENDIX I.—LEAD CARD FORMATS

Two kinds of computer instructions are required to operate FIREFAMILY—program lead cards and job control cards.

Program lead cards are discussed thoroughly in this publication. Below we summarize general information about the program lead cards and suggest general rules for submitting the cards to the computer. Appendix II illustrates the number of pages likely to be produced. Appendix III shows the job-control cards needed to execute FIREFAMILY at Fort Collins and the format of the **passing file**. We have included this information in the Appendices for easy reference by your computer specialist.

There are four types of program lead cards: lead cards one and two control FIRDAT, three controls SEASON, and four controls FIRINF. The identification number, always coded in column 1 of each card, determines how the program interprets the contents of that card. The cards must be properly formatted and submitted to the computer in the correct order. General rules are:

1. The lead cards must be entered from low car number to high for the same weather station.

2. More than one station may be in the same run. (Include a card one for each station.)

3. Order the card "ones" from lowest station num ber to highest.

4. Lead cards three and four do not have to be present in a run.

5. The first card in an entire group must be a card one.

6. The second card in an entire group must be a card two.

7. Once a card two, three, or four is entered, its instructions will remain in effect until altered by another card of the same type.

8. Cards three and four can exist in multiples of three cards each for the same station.

A.—FIRDAT Control—Lead Card One

ITEM	DESCRIPTION AND CARD COLUMN(S)		
1	Card number		(1) _____
2	Administrative owner's name	(2-13) _____	
3	Station name	(14-33) _____	
4	Station number	(34-39) _____	
5	Station elevation in feet (right justify)		(40-44) _____
6	Station latitude, nearest degree		(45-46) _____
7	NFDRS model-slope-herb-climate class combination. (Lead card two allows you to specify four additional combinations.)		
	Model:	A through U but not M	(47) _____
	Slope:	1 through 5	(48) _____
	Herbaceous:	A or P only, annual or perennial	(49) _____
	Climate class:	1 through 4	(50) _____
8	Range of years:	First year	(51-52) _____
		Last year	(53-54) _____
	(Enter 0099 to get all available data)		
9	Fire season:	Beginning month	(55-56) _____
		Beginning day	(57-58) _____
		Ending month	(59-60) _____
		Ending day	(61-62) _____
	(Enter 0101 and 1231 to include entire year. Lead card two allows you to skip a period of few fires.)		
10	Select the indexes, components, and/or fuel moistures for which **frequency distributions tables** and **graphs** are desired. Code a "T" for those you want, an "F" for those you don't want.		
	Variable		
	Ignition component		(63) _____
	Spread component		(64) _____
	Energy release component		(65) _____
	Human-caused fire occurrence index		(66) _____
	Lightning-caused fire occurrence index		(67) _____
	Burning index		(68) _____
	Fire load index		(69) _____
	Fuel moistures (You will get all four dead FM's: the 1-hr, 10-hr, 100-hr, and 1,000-hr.)		(70) _____
11	"T" produces a **daily list** of the weather, indexes, and components. The program resets this item to "F" after the first model-slope-herb-climate combination has been processed. If you plan to choose more than one combination on lead card two (item 5), and you want to see the **daily list** for each combination, code "A". Coding an "F" will suppress the printing of all **daily lists**.		(71) _____
12	"T" indicates that you already have a FIRDAT-created **passing file**. The routine will bypass FIRDAT and go directly to SEASON and/or FIRINF.		(72) _____
13	"T" causes FIRDAT to list only the observed weather elements. No indexes or components will be printed.		(73) _____
14	"T" causes FIRDAT to create a **passing file** for use with SEASON and/or FIRINF.		(74) _____

B.—FIRDAT Control—Lead Card Two

ITEM	DESCRIPTION AND CARD COLUMN(S)
1	Card number (1) 2
2	Lightning risk scaling (LRS) factor. (See Deeming *et al.* 1977, Appendix D). For the first run, enter 01.00, and include the decimal point. On later runs you should adjust your LRS as indicated in INT-39. (2-6) _____
3	Human-caused risk scaling factors. Columns 7-9 contain the average weekday risk. (7-9) _____
	Columns 10-12 contain the average weekend risk. (10-12) _____
4a	The month and day when green-up normally begins. (13-16) _____
4b	The month and day of the first killing frost. (17-20) _____
5	Up to four more model-slope-herb-climate combinations may be entered here (see Appendix Ia, item 7). (21-24) _____
	(25-28) _____
	(29-32) _____
	(33-36) _____
6	If your station has a split fire season, you may enter the low risk period here.
	Beginning month and day (37-40) _____
	Ending month and day (41-44) _____
7	You may select one variable from the following list and use its code number to have SEASON and FIRINF construct a variety of tables. Leave blank if you are not using SEASON and/or FIRINF on this run.

Code	Variable
1	IC
2	SC
3	ERC
4	HCOI
5	LOI
6	BI
7	FLI

(45) ____

8 Your agency's planning methods may vary from those used by the USDA Forest Service. This program will print (and use) the 90th and 97th percentile levels of the index or component chosen in card column 45 if you leave these columns blank. If you code 8095, however, the program will use the 80th and 95th percentile levels.

(46-49) _____

C.—SEASON Control—Lead Card Three

ITEM — DESCRIPTION AND CARD COLUMN(S)

1 Card number (1) ____

2 SEASON will graph and/or tabulate variables from one of the following lists: 1 = NFDRS, 2 = weather elements, 3 = fuel moistures. Choose one list and code it in card column 2. (2) ____

3 From the list chosen in item 2, select any or all of the variables:

Code	List 1 **NFDRS**	List 2 **Weather Elements**	List 3 **Fuel Moistures**	
1	IC	Temp	1-hour	(3) ____
2	SC	RH	10-hour	(4) ____
3	ERC	Wind	100-hour	(5) ____
4	HCOI	Prec. dur.	1,000-hour	(6) ____
5	LOI	Prec. amt.	Woody	(7) ____
6	BI	LAL	Herb	(8) ____
7	FLI			(9) ____

If you wish to see the variable tabulated or graphed, code its number in the correct column; otherwise, leave the column blank.

4 **Seasonal graphs**? "T" = yes, "F" = no. (10) ____

5 **Seasonal tables**? "T" = yes, "F" = no. (11) ____

6 Averaging periods for tables and graphs. Code with an odd number, 01-31 only. (12-13) ____

7 Graph individual years? "T" = yes, "F" = no. Remember that this **single year graph** feature may produce many pages of printout. It also turns off the **persistence probability tables** and the **BI seasonal severity list** and **summary table.** (14) ____

8 Persistence probability variable. Use one variable code from the list you chose in item 3. Code 0 if you do not wish to receive the **persistence probability table**. (15) ____

9 Select up to six upper boundaries for your persistence probability variable. (FIRDAT will do this for you if you place a variable code in column 45 of lead card two.) The boundaries are entered in ascending order, right justified. (16-18) ____
(19-21) ____
(22-24) ____
25-27) ____
(28-30) ____
(31-33) ____

10 **BI seasonal severity list** and **summary table?** "T" = yes, "F" = no. (34) ____

11 Enter the 90th percentile BI value here. Leave blank if you are combining SEASON with a FIRDAT run. (Round off BI value, no decimal point, right justify.) (35-37) ____

12 If you want to compare BI seasonal severity with different average values for the departures and number of days, enter the average yearly departure, including the decimal point, in columns 38-42, and (38-42) ____
enter the average yearly number of days over the percentile in columns 43-47. Leave columns 38-47 blank unless you want this feature. (43-47) ____

Note: You may have up to three SEASON cards in each run. To turn off SEASON, code a "3" in card column 1 and leave the rest of the card blank.

D.—FIRINF Control—Lead Card Four

ITEM	DESCRIPTION AND CARD COLUMN(S)	
1	Card number	(1)___
2	**Adjective class matrix**? "T" = yes, "F" = no. If "T" is coded in column 2, "F" must be coded in column 3. (Both columns 2 and 3 may be false.)	(2)___
3	**Precautions class matrix**? (See above.)	(3)___
4	Variable to be used for the table columns. Choose from the following list:	
	Code Variable 1 = IC 2 = SC 3 = ERC 4 = HCOI 5 = LOI 6 = BI 7 = FLI	(4)___
5	Code up to 10 upper boundary values for the table columns.	
	(5-7) _____ (20-22) _____ (8-10) _____ (23-25) _____ (11-13) _____ (26-28) _____ (14-16) _____ (29-31) _____ (17-19) _____ (32-34) _____	
6	Choose another variable from the list in item 4 for the table rows.	(35)___
7	Code up to 10 upper boundary values for the rows.	
	(36-38) _____ (51-53) _____ (39-41) _____ (54-56) _____ (42-44) _____ (57-59) _____ (45-47) _____ (60-62) _____ (48-50) _____ (63-65) _____	

Note: This card may be repeated up to three times. Turn FIRINF off by coding card columns 2 and 3 false and leaving the rest of the card blank.

APPENDIX II.—OUTPUT PAGE ESTIMATOR

FEATURES	PAGES	TOTAL PAGES*
1) **Header page**	1 page per combination	5
2) **Daily list** (if T)	Total days/50	60
(if A)	Total days x combinations/50	300
3) **Annual summary**	Years x combinations	100
4) **Cumulative frequency**	2 pages x combinations xfrequencies selected	110
5) **SEASON graph**	4 pages x combinations x variables selected x SEASON cards	420
6) **SEASON tables**	3 pages x combinations x variables selected x SEASON cards	315
7) **Single year graph feature**	Multiply item 5 or item 6 x years	8,400 (5) 6,300 (6)
8) **Persistence probability**	6 pages x combinations x SEASON cards	90
9) **BI seasonal severity**	5 pages x combinations	45
10) **FIRINF**	22 pages x combinations x FIRINF cards	330

*With five combinations, 20 years (3,000 days), and everything turned on (three SEASON and three FIRINF cards), the output would be 15,545 pages.

Note: When the **single year graph** feature is on, FIREFAMILY produces a great deal of paper even though it turns off everything else in SEASON.

APPENDIX III.—JOB RUNSTREAMS AND PASSING FILE FORMAT

The Fort Collins Computer Center, home of FIREFAMILY, is equipped with a UNIVAC 1100 series computer and the EXEC 9 operating system. Changes in FCCC equipment or systems may make the following examples and job instructions obsolete.

The first part of Appendix III will help your computer specialist set up the job-control language needed to execute FIREFAMILY at FCCC.

We have included two typical runstreams. The first shows how to access the National Fire Weather Data Library (see Furman and Brink 1975) to obtain historical weather records, execute the FIREFAMILY program, and catalog the **passing file**. Our second example shows how to use a previously created **passing file** as input to the FIREFAMILY routines SEASON and FIRINF.

Appendix IIIb shows the format of the **passing file**.

A.—Running FIREFAMILY Using Historical Weather Data

```
@RUN,P/B YOUR ID,ACCOUNT NUMBER,QUALIFIER,TIME,PAGES
@SYM PRINT$.,,PR .  (Send the output to a high-speed printer.)
@ASG,A FIREDATALIB*PROGRAMS.
@ASG,A FIREDATALIB*21-24. . (Get the fire weather tape.)
@ASG,UP YOUR-DATA. . (Unconditionally catalog the weather holding file.)
@USE 2.,FIREDATALIB*21-24.
@USE 15.,YOUR-DATA.
@XQT FIREDATALIB*PROGRAMS.GETDATA2 . (Get the required weather data.)
  24010700  24010799
@EOF
@ASG,UP PASS. .   (Unconditionally catalog the passing file.)
@USE 7.,YOUR-DATA. .  (Use the data just obtained from the NFWDL.)
@USE 9.,PASS.
@USER*JOB.IDENT MAIL TO      ,FIREMANAGER ,SOMEPLACE MO,87603
  (Use for Fort Collins  printing.)
@HDG,N X.M,66,0,0 .  (Turn off normal page control.)
@XQT NFDR78*FIREFAMILY.FIRDAT1 .  (Execute the program.)
1KOOTENAI NF LIBBY MONTANA        240107 207049C2A2009905090909TTTTTTTTFFT
2 1.00 12 1206010910                          69097
311234567TT01F6
4TF
@SAVE QUALIFIER*PASS.,810301  . (Save the passing file until March 1, 1981.)
MY FIRDAT PASSING FILE'S NAME
  (The qualifier must be explicitly specified and the above file description
   line must be included.)
@FIN
```

RUNNING FIREFAMILY USING A PREVIOUSLY CREATED PASSING FILE

```
@RUN,P/B YOUR ID,ACCOUNT NUMBER,QUALIFIER,TIME,PAGES
@SYM PRINT$.,,PR .  (Send the output to a high-speed printer.)
@ASG,A QUALIFIER*PASS. . (Assign the previously created passing file to this run.
@USE 9.,QUALIFIER*PASS.
@USER*JOB.IDENT MAIL TO      ,FIREMANAGER ,SOMEPLACE MO,87603
  (Use for Fort Collins printing.)
@HDG,N X.M,66,0,0 . (Turn off normal page control.)
@XQT NFDR78*FIREFAMILY.FIRDAT1 .  (Execute the program.)
1KOOTENAI NF LIBBY MONTANA        240107 207049C2A2009905090FFFFFFFFFTFF
2 1.00 12 1205010910                          69097
311234567TT01F3
4FT
@FIN
```

(Parenthetical expressions explain each job-control card.)
UPPER CASE ITALICS indicate where coding will differ from run to run.

B.—Running FIREFAMILY Using a Previously Created Passing File

The **passing file**, a product of FIRDAT, is used to transfer weather, fuel moistures, and NFDRS components and indexes from FIRDAT to SEASON and/or FIRINF. If retained after the FIRDAT run, this computer readable file can be reused as input to SEASON and/or FIRINF. It may also be used as input to future analysis programs.

The **passing file** contains three kinds of records: a flag indicating a change of station or change of station parameters, a header reporting the station parameters, and the daily data values.

FORMATS

RECORD ONE, Flag:

Item	Columns	Type[2]
Flag: 999999999999	1-12	N

RECORD TWO, Header:

Item	Columns	Type
Administrative owner	1-12	A-N
Station name	13-32	A-N
Station number	33-38	N
Elevation	39-43	N
Latitude	44-45	N
Fuel model	46	A
Slope class	47	N
Herbaceous type	48	A
Climate class	49	N
Julian green-up date	50-52	N
Run date	53-64	A-N
Julian first freeze	65-67	N
Beginning and ending years	68-71	N

[2]A-N = Alpha-numeric; N = Integer; A = Alpha

RECORD THREE, Daily Data:

Item	Columns	Type
Station number	1-6	N
Date	7-12	N (year-month-day)
Julian date	13-15	N
Processing option	16	N
State of weather	17	N
Temperature	18-20	N
Relative humidity	21-23	N
Wind direction	24	N (8 point compass)
Wind speed	25-27	N
Max temperature	28-30	N
Min temperature	31-33	N
Max relative humidity	34-36	N
Min relative humidity	37-39	N
Precipitation duration	40-41	N (hours)
Precipitation amount	42-45	N (10.94 written as 1094)
Lightning activity level	46	N
Human-caused risk	47-49	N
1-hour fuel moisture	50-52	N (14.5 written as 145)
10-hour fuel moisture	53-55	N (14.5 written as 145)
100-hour fuel moisture	56-58	N (14.5 written as 145)
1,000-hour fuel moisture	59-61	N (14.5 written as 145)
Woody moisture	62-64	N
Herbaceous moisture	65-67	N
Blank	68-69	
Ignition component	70-72	N
Spread component	73-75	N
Energy release component	76-78	N
Human-caused fire occurrence index	79-81	N
Lightning-caused fire occurrence index	82-84	N
Burning index	85-87	N
Fire load index	88-90	N

APPENDIX IV.— ABBREVIATIONS AND GLOSSARY

Abbreviations

BI	—Burning index.
ERC	—Energy release component
FLI	—Fire load index.
HCOI	—Human-caused fire occurrence index.
HCR	—Human-caused risk.
IC	—Ignition component.
LAL	—Lightning activity level.
LOI	—Lightning fire occurrence index.
LRS	—Lightning risk scaling factor.
NFDRS	—National Fire-Danger Rating System.
SC	—Spread component.
TL	—Timelag.
1-hr TL FM	—1-hour timelag fuel moisture content.
10-hr TL FM	—10-hour timelag fuel moisture content.
100-hr TL FM	—100-hour timelag fuel moisture content.
1,000-hr TL FM	—1,000-hour timelag fuel moisture content.

Glossary

Adjective class matrix—The table that combines the manning classes (usually based on the BI) with the IC to specify the standard levels of fire danger for public information.

Burning index (BI).—An NFDRS value related to the contribution of fire behavior to the effort of containing a fire. The BI measures fire intensity (BI = 10 x flame length).

Components of the NFDRS.—Components include ignition, spread, and energy release.

Cumulative departure.—The sum of the daily departures (usually for a year).

Cumulative frequency.—The sum of all of the frequencies up to and including this one.

Daily departure.—The numerical difference between the daily value of the variable and the 90th percentile value of that variable when the daily value is greater than the 90th percentile value.

Energy release component (ERC).—A number related to the available energy (Btu) per unit area (square foot) within the flaming front at the head of a fire.

FIRDAT.—A routine of FIREFAMILY that combines historical weather records with the equations of the NFDRS to produce frequency distributions of the NFDRS indexes and components.

Fire-danger rating area.—A geographical area within which the fire danger can be assumed to be uniform. It is relatively homogeneous in climate, fuels, and topography.

FIREFAMILY.—A computer program that uses historical weather data for fire planning. Its three major routines are FIRDAT, SEASON, and FIRINF.

Fire load index (FLI).—A rating of the maximum effort required to contain all probable fires occurring within a rating area during the rating period.

Fire season.—A period during which weather and fuels are conducive to wildfires. (Also, see split fire season.)

FIRINF.—A routine of FIREFAMILY that uses data from FIRDAT to create tables of combinations of two NFDRS indexes and components.

Frequency (also relative frequency).—Proportion of occurrences of a value at a particular numerical level compared with all occurrences.

Fuel model.—A simulated fuel complex for which all the fuel descriptors required by the mathematical fire spread model have been specified.

Fuel moisture content (also fuel moisture) (FM).—The water content of a fuel particle expressed as a percent of the ovendry weight of the fuel particle. The six NFDRS fuel moistures are woody, herbaceous, 1-hour, 10-hour, 100-hour, and 1,000-hour.

Header page.—The first page of output, which repeats the user-supplied lead card information.

Herb.—A plant that does not develop woody, persistent tissue but is relatively soft or succulent and sprouts from the base (perennials) or develops from seed (annuals) each year. Included are grasses, forbs, and ferns.

Herbaceous fuels.—Undecomposed material, living or dead, derived from herbaceous plants.

Human-caused fire occurrence index (HCOI).—A rating value formed by combining HCR with today's IC. It is related to the expected number of reported wildfires in the rating area.

Human-caused risk (HCR).—A number related to the expected number of human-produced firebrands capable of starting fires that a rating area will be exposed to during the rating period.

Human-caused risk scaling factor (HCRSF).—A number relating human-caused fire incidence to the IC on a rating area. The factor is a statistic based on 3 to 5 years of fire occurrence and fire weather data that adjusts the prediction of the basic human-caused fire occurrence model to fit local experience.

Ignition component (IC).—The rating of the probability that a firebrand will cause a wildfire requiring suppression action.

Indexes of the NFDRS.—Human-caused fire occurrence, lightning-caused fire occurrence, burning, and fire load.

Lead card.—The user-supplied part of the job runstream which provides information and chooses options for the FIREFAMILY program.

Lightning activity level (LAL).—A numerical rating of 1 to 6, keyed to the start of thunderstorms and the frequency and character of cloud-to-ground lightning, forecast or observed on a rating area during the rating period.

Lightning fire occurrence index (LOI).—A numerical rating of the potential occurrence of lightning-caused fires.

Lightning risk (LR).—A number related to the expected number of cloud-to-ground lightning discharges capable of starting fires that a rating area will be exposed to during the rating period.

Lightning risk scaling factor (LRS).—A factor derived from local thunderstorm and lightning-caused fire records that adjusts the predictions of the basic lightning fire occurrence model to local experience. It accounts for factors not addressed directly by the model such as susceptibility of local fuels to ignition by lightning, fuel continuity, topography, and regional characteristics of thunderstorms.

Manning classes (also manning levels).—The minimum strength of forces which an agency plans to activate at each level of fire danger.

Matrix.—As used in this paper, another word for table.

Passing file.—A product of FIREFAMILY that saves FIRDAT data for later use with SEASON and/or FIRINF.

Persistence probability.—As used in this paper, the fraction of the time that weather will remain the same 2 days in a row.

Precautions class matrix.—A table (used principally in the USDA Forest Service Region 6, the Pacific Northwest) that uses the ERC or the BI with the IC. One use of the precautions class matrix is to regulate industrial forest usage.

Relative frequency.—See frequency.

Runstream (also job runstream).—Series of control cards used at Fort Collins to run FIREFAMILY.

SEASON.—A routine of FIREFAMILY that uses FIRDAT's results to tabulate and graph one NFDRS index, component, or fuel moisture at a time to show seasonal weather patterns.

Split fire season.—Two or more periods of many wildfires separated by a period of few fires.

Spread component (SC).—A rating of the forward rate of spread of a head fire expressed in feet per minute.

Variable.—In this paper, any of the NFDRS indexes or components. In FIRDAT and SEASON, fuel moistures are also considered variables.

☆U.S. GOVERNMENT PRINTING OFFICE: 1982-566-930/95

Main, William A.; Straub, Robert J.; Paananen, Donna M.
FIREFAMILY: Fire planning with historic weather data. Gen. Tech. Rep. NC-73. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1982. 31 p.

This user's guide will help fire managers interpret the output from FIREFAMILY, a computer program that uses historic weather data for fire planning. The guide describes options within the program and explains various tables and graphs necessary for planning. It also provides details which computer specialists need to run the program.

KEY WORDS: Fire weather, fire danger, National Fire-Danger Rating System